UNIVERSITY OF ILLINOIS,

Agricultural Experiment Station.

CHAMPAIGN, MAY, 1892.

BULLETIN NO. 21.

CONTENTS.

HORTICULTURE; A GENERAL REPORT.

The purpose of this article is to present a brief sketch of much of our work in horticulture; and with the outline there is given some hint as to results either obtained or expected, and, in some cases, suggestions as to their applications.

More time than we have yet had must elapse before a great many of our experiments reach a stage at which it would be profitable to report upon them in full. As they reach completion, fuller reports will be made.

VARIETY TESTS.

For variety tests we have growing on our grounds at present 475 varieties of apple, 28 of pear, 40 of plum, 48 of cherry, 8 of peach, 15 of apricot, 2 of quince, 6 of gooseberry, 7 of currant, 120 of grape, 14 of blackberry, 30 of red and black raspberry, and 98 of strawberry.

Variety tests would be made of more value if introducers were compelled to have the stamp of an experiment station before sending out new things. As it is, they may or not, as they please, send things to a station to be tested. If tested and a report made, the report may be used or not, as suits the case. If favorable, it will almost certainly be used for all it is worth; if unfavorable, it will very likely be thrown into the waste basket.

Fruits.

Apples.— It is too soon to expect any definite results from the tree fruits that have been planted since the establishment of the Experiment Station in 1888. From the University apple orchard, planted twenty years ago, a few varieties of value might be added to the lists commonly recommended; possibly two to the list for market, and three or four others to the list for home use.

The apples for market would be Ned and Early Ripe. Ned has somewhat the appearance and quality of Minkler, but its season is from October to January; it came to us also under the names of creek and custard. Mr. Samuels of Kentucky called it Kentucky cream. Mr. Van Deman thought it might be Minkler, but it is not in season at the right time for that. The early ripe is similar in appearance, season and quality to the early harvest. Though not so free a bearer with us, it does not suffer so badly from scab. It is already fairly well known in many places.

For family use there would be Jefferis, Higby sweet, and Sharp's apple. The two former are somewhat known and deserve to be better known. Sharp's, apparently, is not known or described anywhere. The Higby sweet is in season from October to December; the other two, in September.

Grapes.—Among the grapes and berries there has been fruiting enough to make some acquaintance with varieties planted three or four years ago. In grapes, if we should advise only a single variety, it would still be Concord, because Concord has long and successfully stood the test. Worden would be a close second. It is somewhat like Concord, and the Concord is sometimes sent out under the name of Worden when the latter is ordered.

For one who desires a greater variety than is usually recommended by our horticultural societies, Moore's diamond, and some of Roger's varieties, as Brighton, and Massasoit deserve a place. Vergennes, Goethe, and Duchess are among the best keepers and may easily be had in good condition until the holidays.

Blackberries.—In blackberries nothing has so far been found to take the place of Snyder. The Wilson, Wilson jr., and Erie produce with us but few perfect berries. Early king and early harvest, both gone before the Snyder is ripe, are good in their place.

Black Raspberries.—Of black raspberries the Palmer seems the most desirable. It is more productive than the Gregg, of better quality, and nearly as large in berry.

Red Raspberries.—The Turner is still one of the best of the red raspberries for home use. Marlboro and Cuthbert are firmer and on that account better for shipment. Clarke, a rather new variety, is very promising. It seems to have more substance than either of the others and has borne well. In quality it is quite distinct from other varieties.

Schaffer's colossal yields well and presents a fine appearance on account of its large size.

Vegetables.

Beans.—Varieties of beans have been grown quite extensively. The greatest obstacle to the cultivation of beans, other than the Lima, is their liability to rust. Some of the varieties most highly praised by seedsmen rust so badly that in three years we have not been able to grow enough of them to get descriptions. A few of the worst are lazy wives, Indian chief, green flageolet, Yosemite wax. Among those rusting less are the Valentines, refugee, the soup beans as navy, etc., southern prolific. In general the tender podded or snap beans seem to rust worse than the others. The so called rust proof varieties sent out by different seed firms have not seemed noticeably more exempt from disease than other related varieties.

Sweet Corn.—All the varieties of sweet corn offered by leading seedsmen have been tested and full reports have been made in bulletins four, eight, and thirteen.

Pumpkins and Squashes.—Pumpkins and squashes have been grown under all the different names under which they could be found. Sometimes the same name has been applied to different things; but more frequently several different names are given either to the same variety or to those so similar that for all practical purposes there is no difference.

Among the bush or summer squashes there seems to be but little choice. None of them are of much value after ripening. There are several varieties classed as different simply on account of the difference in the form of the fruits; as for instance, white bush scallop and pine apple. Of the winter squashes the marrow under various names, as Boston marrow, etc., have seemed most desirable, because most productive, and they are of very good quality. The Hubbard, with us, has been a shy bearer. The most productive of the pumpkins has been Connecticut field. Those of best quality are Yokahama, a very distinct variety, sweet, tender and fine grained, sweet cheese or varieties closely related to it, Jonathan, and Tennessee sweet potato.

All the pumpkins and squashes grown in the north belong to two natural species, *Cucurbita pepo* and *C. maxima*. Most of the pumpkins belong to the former species, but Jonathan, Tennessee sweet potato, and all the so called mammoth pumpkins belong to *C. maxima*.

All the late squashes except vegetable marrow belong in the species *maxima*. All the summer squashes and vegetable marrow, Brazilian sugar, and a few others belong in the species *pepo*.

The best characters about the fruit for distinguishing the species are the stem and seeds. The seeds of *C. maxima* are much whiter and are usually larger than those of *C. pepo*. The stem of *C. maxima* is pithy or corky on the outside while the stem of *C. pepo* is very woody and hard. The stem of *C. maxima* is nearly round and enlarged,

while that of *C. pepo* is strongly 5-angled. It would have been much better if the term pumpkin could have been applied exclusively to one species and squash to the other. It may not be worth while to try to change now.

WINTER PROTECTION OF PEACH TREES.

Turning down peach trees for winter protection has been tried somewhat and the trials are still going on. Results have been fairly favorable. To prepare for turning down the trees the best method is to plant them with the roots extending in two opposite directions. The roots can be bent, and if any are too large for that, cut them off close to the trunk of the tree. Then by digging the dirt away from one side the tree may be bent down, twisting the roots. Evergreen branches, corn stalks, or coarse straw make a good cover. The tree will not stay down unless fastened in some way.

The varieties of peach differ in hardiness. During the past winter the temperature fell to —12½° F. at one time and to —15° F. at another. An examination of the buds of six different varieties gave the following results:

Variety of Peach.	No. of buds examined.	No. of buds dead.	No. of buds alive.	Per cent of buds alive.
Alexander	121	79	42	34
Lemon cling	151	133	18	13
Roser	144	24	120	83
Thurber	192	62	130	67
Wager	172	157	15	8
Seedling cling	766	170	596	77

The above varieties were kept well cultivated during the entire season, and the treatment of all was the same. An unknown variety growing in sod had 95 per cent of its buds alive when examined at the same time.

We are starting to make a collection of all the varieties reputed exceptionally hardy and expect to grow seedlings from these. There is no reason why a few generations may not give us a peach hardy enough to stand most of our winters and as good in point of size and quality as those now grown. The trees can be covered, of course, and even the tender ones made to fruit; but if a hardy variety can be had, there is no need to cover up tender ones.

PROTECTION OF THE TRUNKS OF TREES.

We are trying methods of protecting the trunks of trees, in varieties where that seems to be the weak point, by the use of boards and building paper; by the growth of plants on the southwest, such as corn or the black raspberry; or by giving the tree a new trunk, as has been so long and ably advocated by Mr. J. V. Cotta, of Nursery, Ill. The piece which forms the new trunk retains its individual character, as may be seen by noticing the overgrowth of a fast growing variety when worked on one of slower growth.

CROSS FERTILIZING AND HYBRIDIZING.

Cross fertilizing and hybridizing have been carried on to some extent, both for the study of the effects of crossing and for the purpose of producing, if possible, new varieties of value. A number of crosses have been made in the apple, as for instance, between Ben Davis and Grimes, Ben Davis and Minkler, or Ben Davis and Duchess, with a view of getting something that will bear like the Ben Davis, but have the better quality of Grimes or Minkler; have the keeping quality of the Ben Davis and the hardiness of tree of the Duchess. Different varieties of strawberries have been crossed and plants are growing from the crossed seed. Blackberry varieties have been crossed, seeds planted and plants are growing. Raspberries have been crossed—black varieties together—red varieties together—black with red, and blackberries with raspberries. We have now ready for planting more than a quart of seed from crossed raspberry and blackberry or from selected varieties.

Results are problematical, but there is certainly great room for improvement in our blackberries and raspberries. There is entirely too much seed for the amount of flesh. When we consider that our apples originated from a crab in no way superior to many of our own native wild crabs, and the excellence that has been developed by cultivation and selection, what may we not expect from our raspberries and blackberries, which are so much better naturally? We have only begun with the raspberry and blackberry group of plants. I believe none of the blackberries or dewberries now cultivated are the result of growing plants from seed, but that all are the result of propagating natural seedlings; and it is not at all certain that we have yet the best of the wild varieties. Most of our raspberries are the result of chance.

During the past three seasons some work has been done in the line of crossing and selecting corn. The results seem to indicate that corn grown from crossing two distinct varieties will be larger than the average of the kinds crossed; or where the parents are nearly equal, larger than either.

It is not certain that this isolated fact, if it prove to be a fact, will be of any value to fruit growers; nor is it certain that the direct results of these corn crosses will yield anything of value in themselves.

There were shown at the last State Fair, samples of what are called Carter's cross-bred wheats. They are as wonderful in their way as the best specimens of the breeder's art among animals. Mr. John Thorpe, now at the head of the Floral Department for the World's Fair, who has been a successful originator of flowering plants, said he could come as near producing a desired variety by growing 100 plants from crossed seed as by growing 1,000 plants from seed simply selected. There is plenty of room for the skillful breeder of plants.

IMPROVEMENT OF NATIVE FRUITS.

We cannot have too much variety in the way of wholesome fruit.

Poor as our wild crabs are considered by many, a taste for them may be cultivated, the same as a taste for the Russian apples, or for tomatoes or celery. Most of the wild crabs seem to be abundant bearers, hardy, and comparatively free from disease.

There is promise of value in our papaw, (*Asimina triloba*).

In Japan the persimmon is their standard fruit. No reason is known why ours cannot be made fully equal to those grown in Japan. Even as they grow native they show a decided tendency to vary, and the best of them are certainly equal to the Japanese as sold in our markets. The persimmon of Japan has had the advantage of thousands of years of man's cultivation and selection.

There may be something worth looking after in our red haws (*Cratægus coccinea*). Some of them are now gathered for jelly and butter.

We have seedlings of all these wild fruits growing and should be glad to get more seeds or cions of exceptionally good kinds. There seems to have been no continued attempt to improve any of them. They all, even in their wild state, vary in shape, size, season and quality. Cultivation ought after a few generations to bring out or strengthen good points. On the side of producing new varieties, we do not know of a more promising field than our native wild fruits. We have many promising varieties of native plums—all or nearly all chance or natural seedlings. Our grapes have been made much of, though the Concord, which still heads the list for general purposes, was a wild seedling of the New England woods. We may hope, however, that the Concord will not long hold its sway; for there are nursery-grown seedlings, crosses and hybrids, which are fast coming to the front, and we may expect the old standard to be superseded by something as hardy, as productive, of finer appearance and better quality. Will not the variations of later generations from Roger's hybrids give us something of value? To be sure nothing has yet been reported in that line, though there would seem to have been abundant time for seedlings to have been grown. If the results of our crosses in corn are to serve as an index, we might expect to find in a second or third generation fruit of the *Vinifera* type on vines of the *Labrusca*. There is a great difference in the susceptibility of fruits to the influence of man. Our grapes have had more time spent on them, extending over a longer period, than have our strawberries; yet the results from grapes are hardly to be compared to the results with strawberries.

A small start has been made in the growth of nuts. The attempts at improvement heretofore have been confined almost exclusively to the pecan and chestnut. Attempts at improvement by growing seedlings

from the best native trees have usually been a disappointment, because the seedlings have been inferior to the tree from which seed was taken, just as 999 of every 1,000 seedlings grown from the Concord grape have been so inferior to the parent as to be unworthy of general distribution. But it must be remembered that while there are comparatively few chances for improvement by growing seedlings there are none from simply budding or grafting.

The filbert and walnut of Europe are too tender for our climate. Why may not our hazel-nut and walnut be improved so as to take their places, and be made valuable crops for the rough lands along our streams?

METHODS OF CULTIVATION.

Grapes.—Since the spring of 1888 a cultivation experiment has been carried on in an old vineyard on the University farm. Part of the vineyard has been kept well cultivated, while the rest is allowed to grow up to weeds and grass, and is mowed over two or three times during the season. During the seasons of 1888 to 1890 no attention was paid to comparative yield, because so large a proportion of the fruit rotted that it seemed undesirable to make comparisons of yield. For 1891 the yield per vine of grapes not cultivated was 17.67 lb. while on vines kept well cultivated the yield was 10.89 lb. per vine. But the vines made a much more vigorous healthy growth where well cultivated than where not and are in better condition for next year's work. The bunches on the cultivated vines were larger and the berries larger, better colored, better flavored, earlier (at least 10 days) and ripened more evenly, than on the vines not cultivated. Pound for pound they were worth nearly twice as much in market, because they were earlier and because they presented a better appearance.

Raspberries.—It is not necessary to tell the practical, progressive fruit grower that it pays to give all crops thorough cultivation. But many farmers and a few fruit growers seem to think it is necessary to cultivate raspberries the first year only; the only attention needed thereafter being to pick the fruit when ripe. With such treatment the plants are not usually worth much after the third or fourth year. With good care the black raspberry plat ought to improve with each year for at least four years, and then last indefinitely. All our raspberries have been cultivated more or less, but some of our neighbors have had plats which were not cultivated the past season. One of them, when asked last summer about his berries, said "I am picking dried raspberries and expected to be able to supply the home demand." A plat of our Gregg raspberries that has been cultivated after the fruiting season only, having the weeds mowed off before the fruit ripened, was as good as the same variety on the grounds of any fruit grower visited during the season. Alongside this plat was another of the same size, kept well tended during the season, which yielded nearly twice as

much as the one only half cultivated, the yields being 272½ qt. and 487½ qt. Although the season was very unfavorable, several growers who visited us said they had never before seen so fine a plat of black raspberries.

Farmers sometimes say when urged to keep better stock, "The improved breeds take more attention to keep them in condition;" or, "The scrubs would be nearly as good as the improved breeds, if as well cared for." There is a half truth in both statements. A similar thing could be said of our fruits. It is care that has made them larger, more productive and improved their quality. Without this same care continued they would tend to revert to their original condition.

FUNGICIDES.

Fungicides have been tried for preventing black rot and mildew of the grape, scab of the apple, leaf blight of the potato, etc. A report of this work has been published in bulletin No. 15, and also in the last report of the State Horticultural Society. We are still experimenting.

There are other uses for both fungus and insect remedies besides saving the crop of fruit. Any disease which attacks the leaves or branches lowers the plant's vitality, causes a less perfect ripening of the year's growth, and, consequently, greater inability to withstand the effects of severe winters. If the apple trees had been in perfect health a few years ago there is no doubt we should have heard much less of the test winters of the early '80's.

WHOLE AND PIECE ROOT GRAFTING.

A study of whole- and piece-root grafting has been begun. For this purpose something more than 2,000 grafts were put up here and were set last spring, though many of them failed to grow.

The principal advocates of the whole-root method claim as its greatest advantage that the graft is set on the collar of the seedling tree, that there alone is the natural place for a union between the trunk of the tree and the root, and that to put the graft on any other part of the root must necessarily make a less perfect union, and, consequently, a poorer tree in the nursery, and a less enduring and perfect orchard tree. They do not advocate the use of the whole root as one would naturally be led to suppose; but what is usually called the upper cut, five to six inches long, from the collar down. We have used roots in the following forms:

Roots ten inches long with the cion set two inches above the collar, on the collar, and two inches below the collar.

Roots cut into two pieces each five inches long, being careful to put the cion in the collar of the upper cut.

Roots cut and cions put in the same as the last, but leaving the side branches on the root.

Roots cut into three pieces each four inches long, again putting the cion on the collar of the upper cut.

In like manner the roots were cut into bits two inches and one inch long.

The conclusions from one year's work are:

The whole root has no advantage over a piece root of the same size. (Size refers to both length and thickness.)

Roots with the small side branches left on gave better results than roots of the same size, with the rootlets cut away.

Roots five inches long gave better results than roots four inches, two inches, or one inch long.

Roots five inches long not trimmed gave nearly as good results as roots ten inches long.

BOTANICAL WORK AFFECTING HORTICULTURE.

The Botanist and his assistant are endeavoring to gain new information upon every opportunity, by observation, experiment, and research.

Much of this work must depend upon opportunities as they arise, such as observations upon special diseases when they appear, and any peculiarities of plant development when they are found. But special subjects are selected upon which work is done more or less continuously. Just now those in hand directly allied to horticulture are:

1. An investigation of the structural physiological union of stock and cion and of modifications observed in different unions.

2. The cause of the disease known as "yellows of the peach tree." A large amount of work has been done by the Department of Agriculture, at Washington, but no definite conclusions have been reached as to the immediate cause. While the disease does but little, if any, damage in this state, it has been very serious in other states.

3. The life history and peculiarities of development of the red rust of blackberries and raspberries.

4. Potato scab. We have during several years made investigations on this peculiar disease and in common with other recent observers have found clear evidence that it is due to a bacterial parasite. Other stations have gone somewhat farther in some lines and have shown that diseased seed carries to the new crop germs of the disease; that the disease may be retained in the ground from year to year; that treating seed with solutions of corrosive sublimate or the copper solutions tends to check the disease, or that spraying the seed potatoes in the furrow just after planting tends to prevent the disease.

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CORN CROSSING.

The systematic breeding of plants is one of the comparatively new things, followed by but few, and of which but little is commonly known, either as to methods or results.

Among the more advanced florists plant breeding, crossing, and hybridizing have been carried on longer and more successfully than among farmers or fruit growers; and the many valuable varieties of flowering plants which have been produced are abundant evidence of the efficacy of skillful work on these lines; but to the great majority of florists such work has been a hidden mystery. A few farmers have attempted to produce better varieties of corn and other plants by crossing: they have done much more by continued careful selection; but outside of experiment stations there has been very little work done and recorded in the way of breeding new varieties of corn, wheat, or oats.

Mr. Carter, of England, and Mr. Carman, of the *Rural New Yorker*, seem to have been the pioneers in crossing or breeding wheats. (The term "breeding" is used here to impress the analogy between rearing plants and animals, for while there are many obvious points of difference there are many points of resemblance. There must in every case, either plant or animal, except in some very low forms, be male and female, and for reproduction in plants as in animals the male and female elements must be brought together; and the parentage of the coming plant can be controlled just as certainly as the parentage of the coming animal.) The pioneer in oats breeding has not yet made himself known. The breeders of corn are not prolific writers and so are not well known.

The work done at the various experiment stations has not yet been well digested. In fact there has scarcely been time for the accumulation of sufficient data from which to make well digested reports. Some of the stations seem to have gone only far enough to study the immediate results of crossing; that is, the effect of the pollen, or male element, on the resulting kernel of corn, making the work in that sense scientific only, as distinguished from the practical. An object with other stations has been the production of varieties which should show points of superiority for the special locality over varieties already grown. In this line Minnesota reported apparent success; but just as success was reached, a fire in their barns destroyed all the seed. If, however, they have kept full notes, and these were saved, they can begin again where they were at the start and reproduce the same variety with much less labor than before, because there will be no need of more than the work leading to the special result.

The work which forms the basis of this report on crossing corn was begun in 1889. Crossing the dent corns, to which reference is made, was done by Professor Thos. F. Hunt, now of Ohio State University, who was at that time assistant agriculturist here.

During this first year, 16 ears were produced by crossing varieties of dent corn, no crosses being made between varieties of different colors. Besides the purely dent corn crosses there were made the following:

Male, or pollen-bearing parent.	Female, or ear-bearing parent.	Ears produced
Leaming [yellow dent]	Mammoth [sweet]	4
"	Triumph "	3
"	8-rowed "	3
Gold coin [yellow sweet]	Mammoth "	2
"	Triumph "	3
"	8-rowed "	2
Stowell's evergreen [sweet]	Mammoth "	2
"	Triumph "	3
"	8-rowed "	4
Queen's golden [pop-corn]	A white dent	2
A white dent	Queen's golden (pop-corn)	2
Black Mexican [sweet]	"	3
"	A white dent	3

During the season of 1890, 158 ears were produced by crosses between different varieties, or by crossing different stalks within the same variety, or by self-fertilizing, that is, by using the pollen of a stalk on silks of the same stalk. The crosses of varieties different from those of the previous year were:

Male parent.	Female parent.	Ears produced.
Gold coin [sweet]	Brazilian flour	2
Queen's golden [pop-corn]	Common pearl [pop-corn]	4
Brazilian flour	Burr's white dent	2
White dent varieties	Yellow dent varieties	6
Yellow dent "	White dent "	3

In none of the crosses between different varieties of dent corn of the same color, or between different varieties of sweet corn of the same color, has there been any change in the crossed ear that could with any certainty be attributed to the pollen. While ears produced by crossing different varieties have varied from each other, and from the type of the variety, they have only varied in the same directions and apparently to no greater extent than ears of the same variety left to form naturally. The typical ear of the Stowell's evergreen differs very decidedly from typical ears of either 8-rowed, triumph, or mammoth; but the ears produced by pollen of Stowell's on either of the others did not differ from the female type in any way, more than did many ears left to be fertilized naturally. It is possible that the pollen of a very smooth dent corn on the silks of a very rough dent variety would tend strongly to make the resulting ears smoother, but the opposite cross would scarcely tend to make the resulting ears rougher.

Ears produced by crossing white sweet corn with pollen of yellow dent corn have been nearly as dark as the male variety, with kernels very much like flint corn in appearance, neither dented nor wrinkled,

and with the taste characteristic of dent corn. The kernels are probably increased in size, at least the seed-coat is not shriveled as is characteristic of sweet corn. The change in form of the seed coat is probably an indication that the kernel has stored more dry matter in proportion to water than it would have done had it been fertilized with pollen of sweet corn. Where both sweet and dent kernels appear on the same ear the dent kernels are always the heavier. Kernels were weighed from five ears, each of which had both dent and sweet kernels with the following results:

		Wt. in grams of 100 kernels.
Ear No. 1	Sweet kernels	27.9
	Dent "	34.5
Ear No. 2	Sweet kernels	23.4
	Dent "	29.5
Ear No. 3	Sweet kernels	39 2
	Dent "	47.4
Ear No. 4	Sweet kernels	22.6
	Dent "	27
Ear No. 5	Sweet kernels	26 4
	Dent "	34.8

Color, where it is a character of the kernel and not of the seed-coat, tends very strongly to pass from one variety to another. The peculiar color of the cranberry did not seem to affect the other white varieties to which the pollen was applied. The cranberry owes its color to the seed-coat entirely; the kernel is white, and the variety is classed as a white corn. In the white, yellow, and black varieties and in crosses of these, which run into other colors, the color is determined by the kernel and not by the seed-coat.

Ears produced by crossing yellow dent corn with pollen of white dent have been lighter colored, and those produced by the opposite cross darker colored than the type of the female parent, though the change has not always been uniform.

Ears produced by crossing Queen's golden pop-corn with pollen of black Mexican sweet corn showed the black color in varying degrees in most of the kernels, but were otherwise unchanged.

Ears produced by crossing a white dent with pollen of black Mexican had kernels varying in color from white to black. More than half the kernels were wrinkled and had the taste characteristic of sweet corn ; while the rest, though showing the black color as much as the wrinkled or sweet kernels, were only less dented than is characteristic of the variety. The taste was not modified.

Ears produced by crossing Brazilian flour corn with pollen of gold coin sweet corn were nearly as yellow as the gold coin, and the kernels were flinty in outward appearance.

Ears produced by crossing Burr's white dent with pollen of the Brazilian flour corn showed no positive results of the cross.

Ears produced by crossing white sweet corn with pollen of yellow sweet corn were nearly as yellow as the pollen-bearing variety.

Ears produced by crossing white dent with pollen of Queen's golden pop-corn were nearly as dark as the pollen-bearing parent, and were less dented than is characteristic of the variety. The smoothness may or may not have been an effect of crossing.

Ears produced by crossing Queen's golden with pollen of white dent seemed lighter in color but were otherwise unchanged. Though the kernels of the dent corn weigh nearly two and one-half times as much as the pop-corn the pollen of the dent corn seemed to make no difference in the size of pop-corn kernels.

Ears produced by crossing the white pop-corn, common pearl, with pollen of Queen's golden were very strongly marked with the yellow color of the male parent.

One of the principal things to be learned from making some of these crosses of widely different varieties is the degree of certainty which can be felt in the work done. For this purpose the crosses in which yellow dent has been the male and white sweet varieties the female, yellow sweet male and white sweet female, and yellow pop-corn male and white dent female have been the best. On nineteen ears produced by these various crosses there were found only two kernels which did not show distinctly the effects of the pollen, and these two kernels were pretty certainly not fertilized with the pollen intended. In the case of sweet corn stalks bearing two ears, where only one was crossed and the other left to be naturally fertilized, there was no indication of anything but sweet corn pollen on the naturally fertilized ears.

The results obtained from planting crossed seed have been of more importance than the immediate effect of crossing, not so much in themselves perhaps as in the conclusions which may be drawn from them. None of the purely dent corn crosses have been used for seed. If they had been, some of the conclusions drawn from growing the others might have been modified. Parts of most of the ears produced by the other crosses were planted in small plats, one by two rods, with but little space between them. During the first growing season the uniformity of the crossed plats was very noticeable. Of 142 plats planted with sweet corn, pop-corn, and these crosses, it is safe to say there was as much uniformity in any one of the crossed plats as in any, and very much more than was found in most, of the plats planted with pure varieties.

The plats in which Leaming was used as the male parent resembles decidedly that variety.

The plat in which the white dent was the male and Queen's golden female resembled the dent; while the opposite cross, Queen's golden male and white dent female, produced a plat intermediate between the two parents in character.

The plats from seed produced by using the black Mexican as male and the white dent as female parent, resembled decidedly the dent corn.

The plat planted from the gold coin-flour corn cross, produced stalks more like the common dent corn than like either parent. While the gold coin occasionally produces suckers and the flour corn characteristically two to four or more, each of which reaches nearly the size of the parent stalk, the stalks from crossed seed produced no suckers.

The stalks from Queen's golden-pearl pop-corn cross were in type between the parents but larger than an average size of the two.

The number of rows of kernels on the ear seemed to be modified about equally by each parent. The Leaming has 18 to 24 rows of kernels, and the mammoth sweet 12 to 16. The ears grown from the cross had from 14 to 18 rows. Both the 8-rowed sweet and triumph have 8 rows of kernels. The corn grown from the Leaming-8-rowed cross had 10 to 14 rows of kernels ; while those grown from the Leaming-triumph cross had from 10 to 16 rows.

The number of ears to the stalk tended to follow the same type as the stalk. As an illustration, the black Mexican corn usually produces one ear, sometimes two ; the pop-corn usually produces two-eared stalks, though frequently three-eared. The cross between the two varieties had very much the appearance of Queen's golden as it grew, and most of the stalks bore two ears, while a few bore three.

On these plats of crossed corn a large number of cross and self-fertilizations were made, though not going outside of the plat for the pollen used in the crossing. The ears so produced and other selected were used in the second year's planting.

When the crossed plats were husked the ears from each plat were as uniform as is common with varieties of corn. The corn grown from the crosses of different varieties was plainly modified to about the same extent by each parent. The corn produced by using the pop-corn and dent corn as parents seemed to show the effect of the male more than of the female parent, those in which the pop-corn was the male parent being more flinty than those in which the dent corn was the male parent.

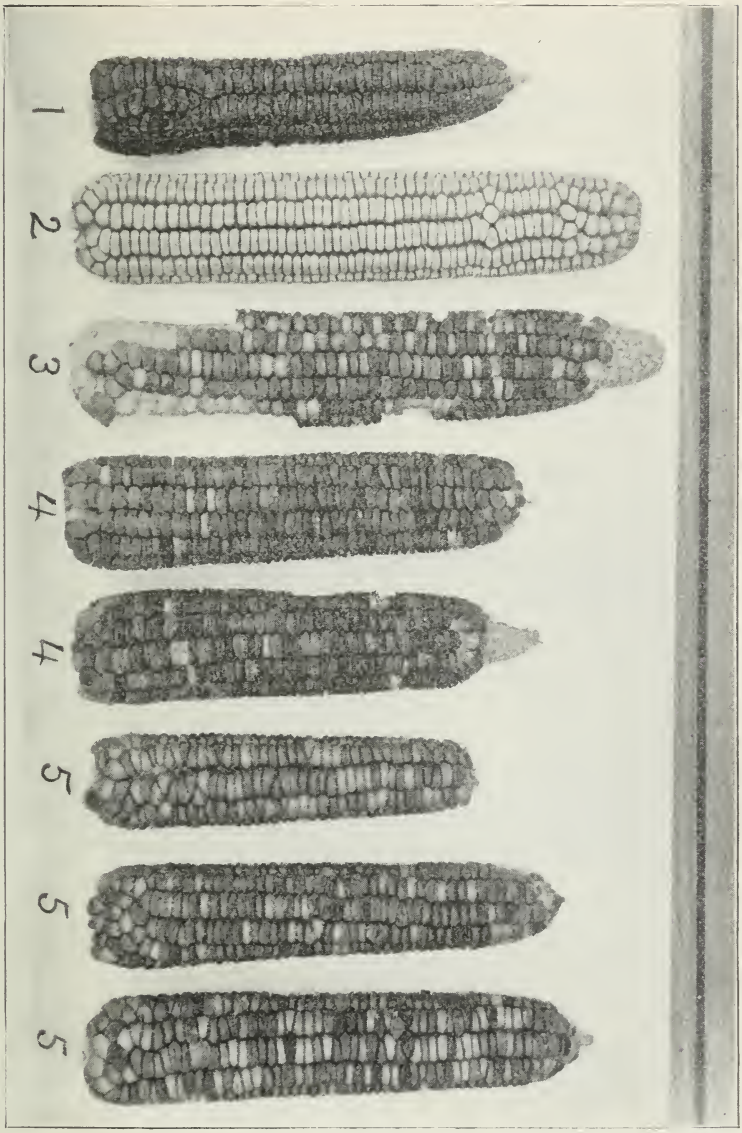
DESCRIPTION OF PLATES.

Plate 1. Black Mexican-white dent cross.—Ear No. 1 is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 shows the immediate result of the cross, corn from which was planted to produce 4 and 5. No. 4 is corn grown from the wrinkled, or sweet, kernels of No. 3. No. 5 is corn grown from the dent kernels of No. 3.

Plate 2. Queen's golden-common pearl cross, showing increase in size of cross-bred corn.—Ear No. 1. is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 is corn grown from the cross between 1 and 2. The immediate result of the cross is not shown.

Plate 3. Leaming-triumph cross.—Ear No. 1 is the type of the variety used as the male parent. No. 2 is the type of the variety used as the female parent. No. 3 shows the immediate result of crossing. No. 4. corn grown from planting No. 3.

Plate 4. Corn grown the second year from the Leaming-mammoth cross.—Ears No. 1 and 2 are corn grown from yellow dent kernels. No. 3 and 4 are corn grown from white dent kernels. No. 5 and 6 are corn grown from sweet kernels. No. 1, 3, and 6 show ears most nearly approaching the general form of the Leaming. No. 2, 4 and 5 show ears most nearly approaching the general form of the mammoth sweet corn.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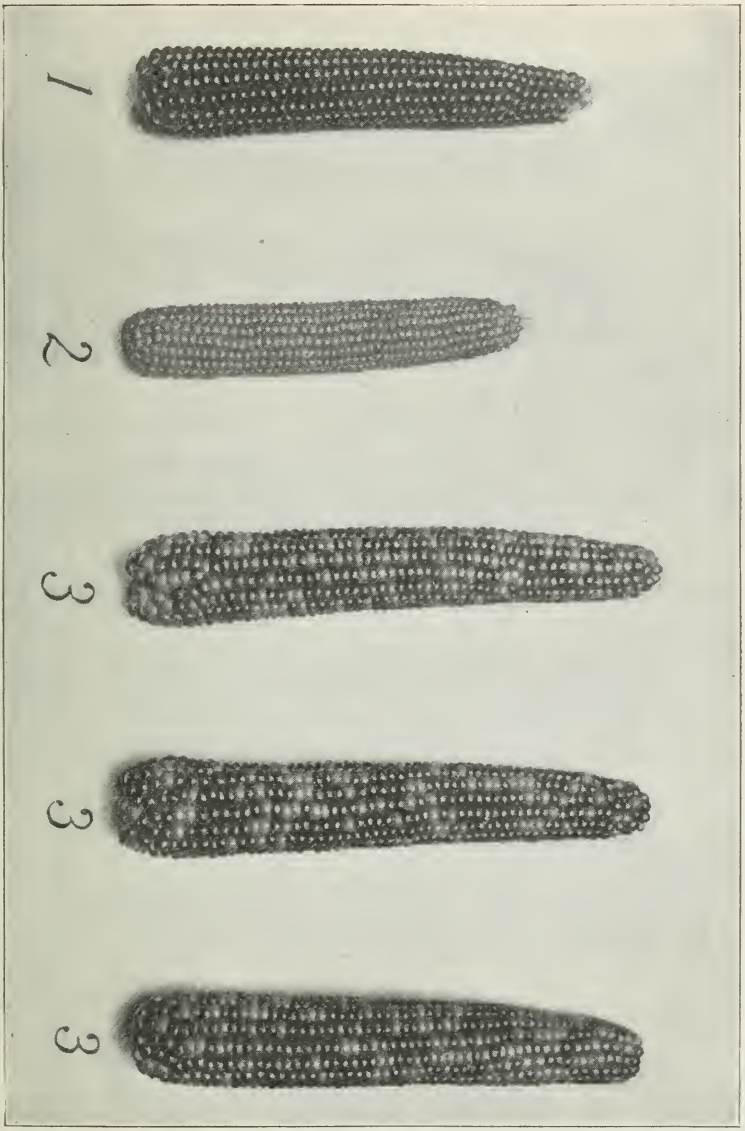
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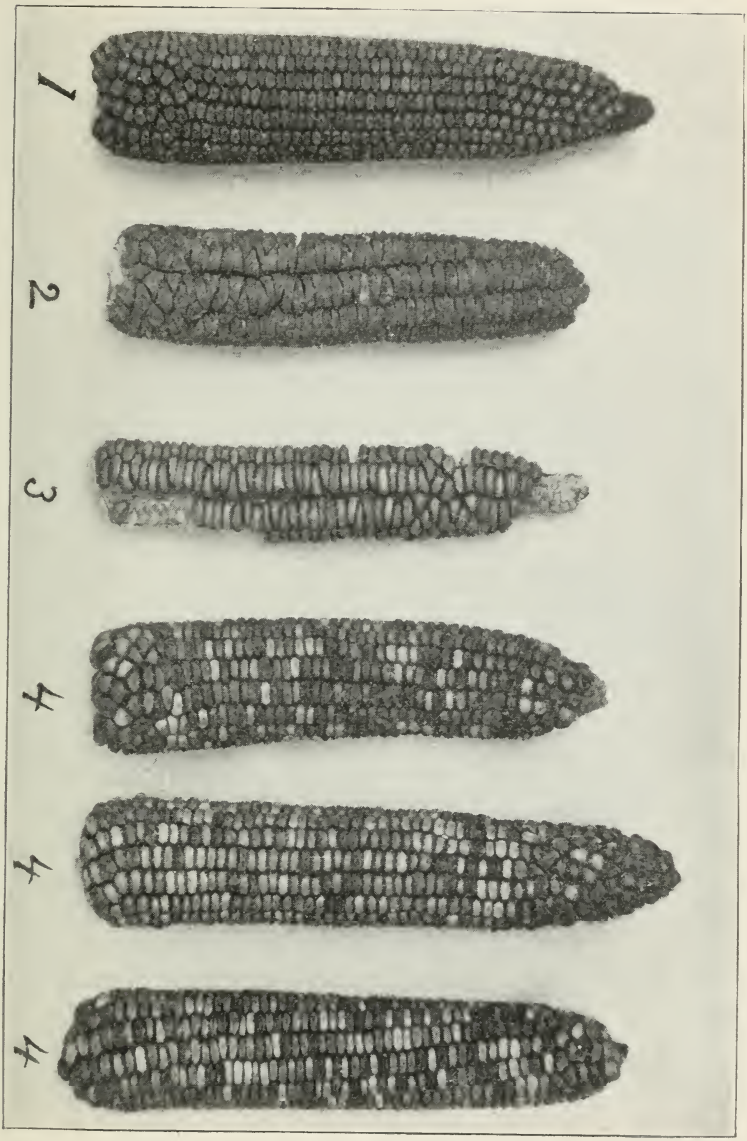
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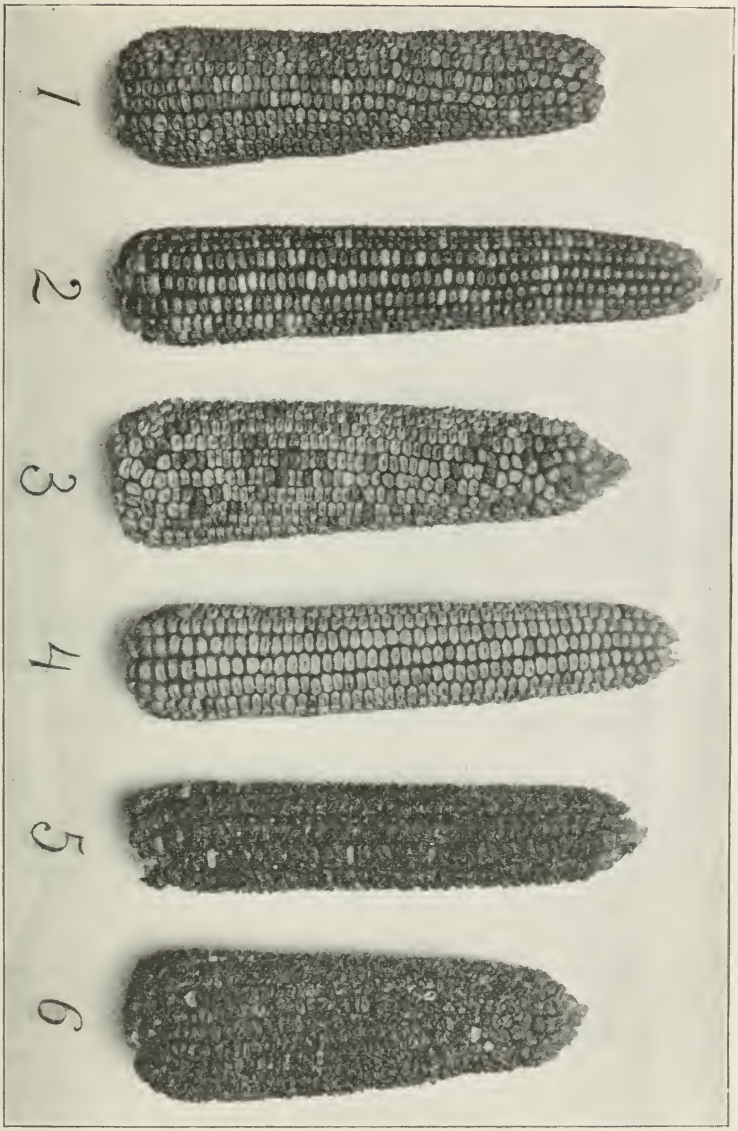
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The corn grown from the cross between the black Mexican and Queen's golden seemed to be about equally modified by both parents, with kernels both flint and sweet and showing shades of all the primary colors and white besides. The corn grown from the cross between Leaming and the different varieties of sweet corn showed a modification of kernels similar to that found in the black Mexican-white dent cross at the beginning of the first generation ; but with a decided tendency of many ears toward the flint type, some of them going so far that, except for the sweet corn kernels in them, they might be taken as types of flint corn. The self-fertilized ears showed the same modification of kernels as those naturally fertilized, proving that each kernel of the crossed corn had in itself the power to produce both sweet and dent corn. There were comparatively few kernels in the corn grown from the crosses between dent and sweet corn that were not distinctly either sweet, or dent in character.

The sweet and dent kernels of the black Mexican-white dent cross were separated and planted in different plats. The result is well shown in plate 1, page 87, in which the ears numbered 4 were grown from sweet kernels and those numbered 5 grown from dent kernels, both taken from ear number 3 of the same plate.

The corn grown from the crossed seed was in nearly all cases clearly increased in size as a result of crossing, the cases in which the opposite result was reached, being the cross between black Mexican and white dent (which was grown in a place very unfavorable for it), and that between Stowell's and 8-rowed sweet. Plate 1 shows one of the instances of decrease of size while plates 2 and 3 show an increase of size. The ears shown as types of the varieties used in crossing are selected typical specimens of the varieties and the ears shown as grown from the crossed seed are typical of the cross-bred corn.

The table on page 97 will give a still further showing of results from the corn grown the first year after the cross and for the second also in cases where the corn has been grown a second year. The weights given are for thoroughly air-dry shelled corn. The yield of plats as a whole, are not given because estimates of yields from such small plats have heretofore been so very unsatisfactory. It is hoped that some of the work outlined may be done soon on a larger scale, so as to give more trustworthy results as to yield.

Corn grown from the crosses the second year has continued to be comparatively uniform in type where the parent varieties were similar; but where the parent varieties were widely different, as in the crosses between sweet and dent, the progeny has tended strongly to run back to the parent forms, while at the same time taking on other forms different from either. This is shown in part in plate 4, p. 93, which is made up of ears of the second generation from the Leaming-mammoth cross. The ears numbered one and two were grown from yellow dent kernels; those numbered three and four, from white dent

kernels; and those numbered five and six from sweet kernels. The ears numbered one, three, and six approach in type of ear to the Leaming, while the rest of them are similar to the mammoth. There are many gradations between the two forms, and among the ears grown from the white or yellow dent kernels there are some which approach the flint corn type much more than ears 2 and 4 shown in the plate.

The black Mexican-Queen's golden and black Mexican-white dent crosses show still more variation in the second generation than is shown by the crosses of Leaming and sweet corn. The black Mexican-white dent cross showed but little tendency to run back to the dent type, but a strong tendency toward sweet and flint types.

Nearly all the corn grown a second year from the crosses is smaller than that grown the first year, though most of it is yet larger than the average size of the parent varieties. The cause of this apparent decrease in size, as compared with the previous year, can only be guessed at. It cannot be attributed to the season, because the Queen's golden-common pearl pop-corn and gold coin-flour corn crosses grown in 1891 show as large a proportionate increase in size of ear as is shown in any of the crosses grown in 1890. There is probably a strong natural tendency in the crosses to revert to the size as well as the form of the parent types. This is shown in the Leaming-sweet corn crosses in which the corn reverting to the dent is larger than that reverting to the sweet types. Or the loss of size may be due to a diminution in some way of the vigor imparted by crossing. Each plat being planted from a single ear there would necessarily be close inbreeding, which it is generally admitted tends to deterioration. That there was very little mixing of the corn in one plat with that in another is shown by the character of the corn grown from selected seed, which in very few cases showed anything different from the corn grown from seed which was artificially crossed and so known to be pure. Plats grown from self-fertilized seed were in most cases notably inferior in size and vigor to the plats grown from crossed seed or from seed simply selected. This is shown to some extent in the last column in the table on p. 97. (As used in the table the term means a cross between different stalks of the same plat and not as in the other case between different varieties.) The table does not give so convincing an illustration of the bad effects of self-fertilization as the plats themselves did when growing, or as the corn did when husked and thrown into piles. One plat from self-fertilized seed, had nearly half the stalks deformed in such manner that instead of standing up straight they turned off nearly at a right angle at or near the joint where the ear was produced, thus throwing the tassel on a level with or below the ear. Many of the tassels were very deficient in pollen. In another plat from self-fertilized seed nearly all the tassels were abortive. All the plats from self-fertilized seed produced a greater proportion of barren stalks and of poorly filled ears than the plats of the same varieties either from crossed seed or from

RESULTS FROM CROSSES OF CORN.

Cross.	Wt. 10 ears of the male variety.	Wt. of 10 ears of the female variety.	Ave. wt. 10 ears of the two parent varieties.	Wt. of 10 ears grown from cross the first year.	Wt. of 10 ears the second year after the cross, oz.
White dent-Queen's golden.	81	34.5	57.75	76	Ears like the dent type.....64 Ears like the pop corn type.52.5
Queen's golden-white dent.	34.5	81	57.75	64	Ears like flint corn.....55 Ears like pop-corn type.....47.5
Black Mexican-Queen's golden.....	36	34.5	35.25	47.5	Types not separated.....43.5
Queen's golden-common pearl pop-corn.	34.5	27.5	31	42	Not grown a second year.
Leaming-mammoth	87.5	61.5	74.5	91	Corn grown from yel. dent k.86 Corn from white dent ker...90 Corn from sweet kernels....74
Leaming-mammoth	87.5	61.5	74.5	82	Not grown a second year.
Leaming-mammoth	87.5	61.5	74.5	80.5	Not grown a second year.
Leaming-triumph	87.5	46.5	67	83	Corn from dent kernels.....86 Corn from sweet kernels....68
Leaming-8-rowed	87.5	41	64.25	72	Corn from white dent ker...80 Corn from yellow dent ker..75 Corn from sweet kernels....58
Gold coin-flour corn.....	63	39	51	78	Has not yet been grown a 2d year.
Black Mexican-white dent.	36	81	58.5	51	From flint ker. of flinty e...53 From flint ker. of sweet e...40 From sweet ker. of flint e...39 From sweet ker. of sweet e..38.25
Stowell's-8-rowed	57.5	41	49.25	47	From selected ears.....49 From self-fertilized ears....38 From cross-fertilized ears...43
Stowell's-triumph	57.5	46.5	52	52.5	From self-fertilized seed....31 From cross-fertilized ear....48.5 " " " " ....41 Seed from selected ears....54 Seed from self-fertilized e...39
Stowell's-mammoth	57.5	61.5	59.5	61	Self-fer. ear, plat 88.....43 " " " 76.....52 From cross-fer. ear, plat 86.55 " " " " 87.45.5 Seed from selected ears.....55
Stowell's-gold coin.....	57.5	62.5	60	62.5	From self-fer. ear, plat 89...48 " " " " 90...54 " " " " 91...54 Seed from selected ears.....58 Seed from self-fer. ear.....48
Gold coin-triumph.....	62.5	46.5	54.5	58.5	From cross-fer. ear, plat 93.56 " " " " 92.50 Seed from selected ears.....49
Gold coin-8-rowed.....	62.5	41	51.75	56	Seed from selected ears.....50
Gold coin-8-rowed.....	62.5	41	51.75	58	Not grown a second year.

seed naturally fertilized. The table giving the weight of ten selected ears of corn from self-fertilized seed and of ten ears from crossed or from selected seed does not give a correct idea of the inferiority of the corn from the self-fertilized seed because it does not take into account either the greater proportion of abortive stalks or of small and poorly filled ears.

From the work so far done there seems to be no way of telling beforehand what varieties will when crossed produce corn of an increased size and what will not. Some of the varieties which may be supposed to be most nearly related as the sweet corns, have shown but little increase when grown from crossed seed, while two varieties of pop-corn, which would seem as nearly related, to each other as the varieties of sweet corn, gave a very decided increase in size when grown from crossed seed. The corn grown from the cross of black Mexican and white dent, two widely different varieties, showed a decrease of size, while corn grown from a cross of flour corn and gold coin, varieties apparently as widely different as any crossed, gave ears showing the greatest proportionate gain in size.

It would be desirable to have a more perfect knowledge of the development of the races and varieties of corn. Many of our varieties of sweet corn are the result of accidental or intentional crosses with varieties of dent corn. This is especially true of the evergreen types, such as Stowell's, old Colony, gold coin, and others, some of them giving evidence of having been crossed two or more times. There are indications that one of the varieties of pop-corn, Queen's golden, is the result of a cross between another variety of pop-corn and a yellow dent variety. A more accurate knowledge of the parentage of varieties already possessed would be of value in the attempt at further improvement, as well as of scientific interest. The work of crossing and growing crossed seed has given some clews though not enough yet for publication.

In the production of new varieties by crossing it will seldom be desirable to cross two varieties that are very widely different from each other. It is probable that, on the whole, selection with occasional partial changes of seed will give more permanent as well as more satisfactory results for the general farmer than would the continual crossing and breaking up of well fixed types; though there does seem reason to believe that the crossing of such distinct and well fixed types will, for the time being at least, give larger corn and better yields.

It has long been a favorite theory among farmers that an occasional change of seed is advantageous. So far as is known no reason for the supposed benefit has ever been given. If the change seemed to prove advantageous all the good was attributed to the change of seed, as though change alone were a sufficient explanation. Where a grower continues to save his own seed year after year from the same lot of corn, there is what may be termed a sort of inbreeding, more or

less close according as the acreage grown is large or small. If the same principle is applicable to corn as to our domestic animals, we should expect this inbreeding to tell sooner or later on the health, vigor, and size of the progeny. Among plants in a state of nature, where there must be much in the way of line breeding and some inbreeding, there is often brought into a community seeds only very distantly related, as where the blue jay carries acorns from one part of a forest to another sometimes many miles distant. When an acorn thus carried grows into a fruiting tree it brings in an element more or less distinct, just as the breeder of animals does when he goes to a herd more or less distantly related to his own to obtain stock for breeding. If advantage to the farmer comes as a result of making a complete change of seed, it must be because the seed grower is a more successful producer from some cause or causes than the seed buyer. But where the advantage comes through only a partial change it may be due to some other cause. It may be that the new introduction is superior, but has parted with some of its superiority so that the result is only an average of the two lots combined; or it may be that the introduction of the new strain or variety has not only added vigor to that before grown, but has itself taken on new vigor as a result of being grown with something of a strain or variety more distantly related.

There can be no doubt but that our cereals are as amenable to the breeder's art as are any other plants, or as animals. It is only a question of taking hold intelligently and working faithfully. If the man with false ideas as to plant breeding can succeed in making improvements, the man with correct notions should be so much the more successful.

This work gives us a clew to the relative prospects of improvment in other lines by cross breeding. A variety or type that is strongly fixed is more apt to transmit characters than one poorly or not at all fixed. If we should try to improve corn by crossing the product of two of these cross-bred groups of corn we should expect to get as a result a few superior ears with a very large proportion of inferior ones. Even in our well selected varieties that have been picked for years with reference to given points of excellence, the tendency to run back to inferior forms is so strong that the grower would save hardly one-tenth of his crop for his own seed. If our well selected varieties deteriorate thus when constantly and carefully selected, two varieties that have been long selected for opposite or widely different qualities must when crossed tend to neutralize most strongly the very traits which we have with so much pains brought out and maintained. If, on the other hand, the varieties crossed have long been selected on the same or very similar lines, there seems to be no reason why occasional crossing will not tend to fix more strongly the desired characters.

This idea carried over to the fruits (perennials) brings up the question whether or not there is after all much to be gained by crossing.

Outside of the wild species, there is nothing among them that would answer to the well selected varieties of corn, to form a basis from which to make a start. Apple trees from seed are propagated as varieties only when they differ from every other known variety. If a seedling of Ben Davis did not differ in some very noticeable character from its parent, there would be no thought of its perpetuation. Thus there are no varieties of apple in the sense that there are varieties of corn; and because we do not have a permanent type fixed by sexual generation, we cannot expect anything like the uniformity in growing natural seedlings, or seedlings from crosses of similar varieties of apple, that we should obtain by growing corn when bred pure or when pure and similar varieties are crossed.

METHODS OF CROSSING.

In doing this sort of work, or any other, for that matter, experimentally, it is essential that it be done in such a way that we are sure of our results. It will not do to find a few kernels in an ear differing from the rest and guess that they were crossed by some other variety growing near or that they had reverted to a former type. Such work leads only to a tangled maze. But having followed accurate methods and found that some good may be expected to come as a result of similar work on a larger scale, the methods of precision, may in a measure be laid aside, and something more practical used.

For our experimental work we have found the best method to be to cover up, before the silks are out, both the tassel and the coming ear, with a closely woven cloth bag. Covering the tassel of the stalk desired for a male parent insures a full supply of pollen, which seems to retain its vitality for several days if kept dry. Covering the shoot or prospective ear keeps away pollen not wanted. When the silks reach a length of three or four inches, the ear is ready for fertilization. We then gather the pollen on a sheet of smooth paper and roll it up funnel shaped. Next raise an umbrella and hold it in such a way as to keep all flying pollen from the ear, remove the bag, and apply the pollen until the silks are almost hidden. In favorable corn weather a single application of pollen is sufficient. Everything is to be kept carefully labeled.

For the farmer who wishes to undertake something of this kind on a larger scale, the best way would be be to plant a field, except one or more rows in the middle, with the variety proposed to be used as a male parent, and to plant in these rows that were left the other variety. As soon as the tassels come out cut them off from the female variety; and it would be well at the same time to cut them off from all the inferior stalks of the male variety.

The following are some of the most obvious conclusions drawn from the work of crossing corn:

The ear of corn may be as readily fertilized by pollen from its own stalk as by the pollen of another stalk. A stalk grown by itself fails to make a perfect ear only because the wind carries the pollen away.

The classes of corn, as dent, sweet, pop, and flour, can be intercrossed with perfect freedom. Corn cannot be a improved by self-fertilization.

There seems to be a strong tendency in the progeny of the crosses of the different classes of corn, dent, sweet, and pop, toward corn of the flint type.

The results from planting different ears of the same cross are apt to be quite different, and what appears to be the best ear does not always give the best results. The three ears produced by crossing mammoth with Leaming were all fertilized by the same pollen. The three ears planted separately produced lots of corn differing from each other fully as much as many of our well marked varieties. One of the three ears produced by crossing was decidedly superior in size and appearance to the other two, yet one of the inferior ears produced the largest and best corn.

G. W. McCluer, B. S., *Assistant Horticulturist.*

SWEET CORN, THICKNESS OF PLANTING, 1891.

Experiment No. 136.

May 12, 1891, 15 plats of sweet corn of three varieties were planted to note something of the effect of thickness of planting on the yield. All the plats were of 9 rows, each 2 rods long, 1-40 of an acre. The varieties used were Cory, Landreth's early or Burlington, and Roslyn hybrid.

Cory is the earliest and smallest variety commonly cultivated, usually growing about four feet high.

Burlington is nearly as early as the Cory but of larger growth, making stalks usually 5 to 6 ft. high, and much more leafy than the Cory.

Roslyn hybrid is one of the largest growing varieties of sweet corn, very similar in general character to the Stowell's, growing usually 7 to 8 ft. high, large and leafy.

Plats 1 to 5, Cory; 6 to 10, Landreth's early; and 11 to 15, Roslyn hybrid. The corn was all planted in hills. On all the plats the rows

were 3 ft. 8 in. apart. In plats 1 and 6 the hills were put 12 inches apart; in plats 2, 7, and 11 the hills were planted 18 inches apart; in plats 3, 8, and 12 the hills were planted 24 inches apart; in plats 4, 9, and 13 the hills were planted 30 inches apart; in plats 5, 10, and 14 the hills were planted 36 inches apart; and in plat 15 the hills were 42 inches apart. The corn was thinned June 1st to 4 stalks per hill.

Plats 4, 5, 7, and 8 were very badly affected by the bacterial corn disease, described in bulletin No. 6, August, 1889. The other plats, as was most of the corn in this vicinity, were also affected but not to such an extent as those noted. Very early varieties of corn seemed more affected than the later ones that were planted at the same time. Some of the early corn grown by market gardeners was entirely destroyed. The corn first assumes a yellowish appearance, stops growing, and then, in bad cases, rots off at the ground.

The corn was given the ordinary field cultivation.

Owing to the diseased condition of the plats all the ears and nubbins in each plat were counted together as ears, and all were then weighed, and no further account taken of them.

The following table gives results:

YIELD OF SWEET CORN PLANTED AT DIFFERENT DEGREES OF THICKNESS, 1891.

Plat.	Variety.	Distance of hills apart, inches.	Number of ears.	Weight of corn, lb.
1	Cory	12	481	30
2	"	18	382	22
3	"	24	377	27½
4	"	30	264	18½
5	"	36	219	13
6	Burlington	12	671	72
7	"	18	571	53½
8	"	24	473	61½
9	"	30	419	64
10	"	36	379	68
11	Roslyn hybrid	18	295	60
12	"	24	276	65
13	"	30	260	68
14	"	36	268	69
15	"	42	288	98

G. W. MCCLUER, *Assistant Horticulturist.*

THE LATE SEASON AND THE CORN CROP.

The situation as regards the corn crop for 1892 is serious in Illinois as well as in other corn growing states. Not for many years has there been so small an acreage planted in Illinois at corresponding date, May 12th, as now. Much land remains unplowed. The temperature is low, the soil cold. Many thousands of acres of low lying land are either covered with water or thoroughly saturated. But with favorable weather in future there is no reason for panic or fear of a failure of the crop. Trials at this Station for four years past show that good crops may be expected, in seasons of ordinary character, from planting any time in May. The best yields have come from planting between May 11th and 16th. If the planting can be completed in Central Illinois by May 25th, or even May 30th, the land being in good condition and late maturing varieties avoided, there need be little anxiety so far as date of planting is concerned. Fair crops of corn may be secured by planting early maturing varieties as late as June 10th, should that be necessary, if the season afterward be favorable. Late planted corn will mature in a less number of days than corn of the same variety planted earlier.

It is believed to be better to wait until the ground is fairly dry rather than either to plow or plant while it is very wet. Time and labor spent in getting the ground in good condition and free from weeds will probably be well repaid, even at the cost of two or three days longer delay in planting.

Where overflowed lands do not become dry until too late for the corn crop and then do get in good working condition, it is probable so large a crop of good stock food can be procured in no other way so quickly and cheaply as by sowing the land to millet, which can be harvested in time to permit the sowing of a wheat crop in September.

G. E. Morrow, M.A., *Agriculturist.*

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The bulletins of the Experiment Station will be sent free of all charges to persons engaged in farming who may request that they be sent.

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